BY MACHEL ALLEN

BRAIN MACHINE INTERFACE (BMI) FOR SPINAL INJURIES

PRODUCT OVERVIEW

Brain-to-machine-interface (BMI) that facilitates the healing of Spinal Injuries.

PRODUCT DESCRIPTION

The Product is designed to facilitate the healing of scar tissues along the vertebrae column. This works perfectly for persons having a handicap that hinders motor skills. The BMI performs this operation by generating a series of electro-magnetic propagations throughout the vertebrae column. It will also be designed to target specific areas of extreme abrasion(s) that affect proper blood flow to facilitate the easy flow of blood (as before injury), so that patient(s) once again would experience the use of their limbs. The device will be engineered as such to cause the brain, where necessary, to (possibly) adjust its own internal frequencies (in Hz) and pitch (in W s/cm^2) to aid in this process. It will be disclosed that through the adjustment of frequencies (in Hz) and energy density (in W s/cm2) scar tissues can be corrected.

PROJECT PLAN

Once approval have been given by FDAs and the WHO, attempts would be made to make contacts with companies/organizations in the "Silicon Valley", California of the United States and Moscow, Russia (for the Arsenide). Once the technology has been carefully designed and engineered, contacts will be made with Singapore for Medical Experimentations and Testing at their State of the Art Medical Laboratories. [This is subject to change but stands as is]

PHYSICS-BASED TRANSFER LEARNING

Physics-Based Transfer Learning is where one trains a model to perform one task and then uses the information/knowledge acquired in the completion of another task. It deeply involves the transferal of information from one experience and applying such to another situation under a similar heading. This greatly will improve efficiency of a learning agent.

Transfer learning (TL) is a research problem in machine learning (ML) that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. For example, knowledge gained while learning to recognize cars could apply when trying to recognize trucks. This area of research bears some relation to the long history of psychological literature on transfer of learning, although formal ties between the two fields are limited. From the practical standpoint, reusing or transferring information from previously learned tasks for the learning of new tasks has the potential to significantly improve the sample efficiency of a reinforcement learning agent. (Jeremy West et al., 2007) (George Karimpanal et al., 2019)

BY MACHEL ALLEN

THE HUMAN BRAIN: NEURO-TRANSMITTANCE

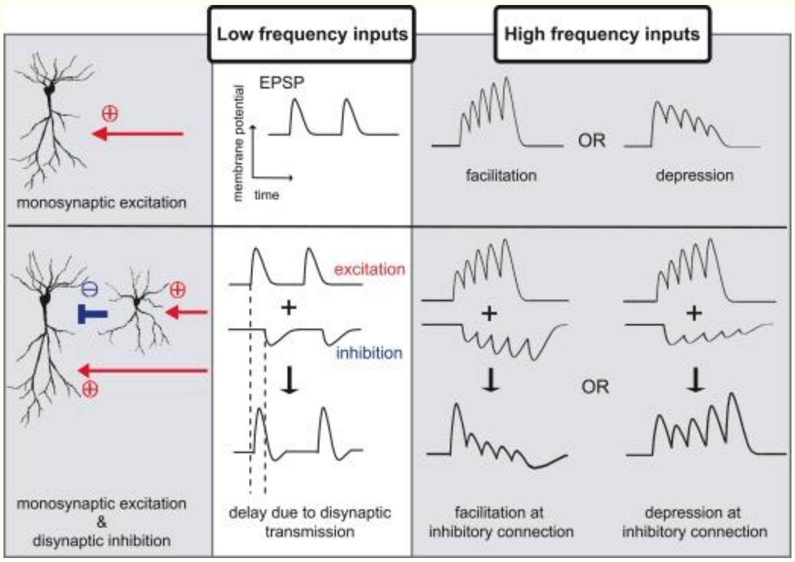
A number of studies suggest that the brain exhibits functional localization, i.e. each brain region has a somewhat specialized role (Boling et al., 2002; Passingham et al., 2002). Most animal behaviors require the coordinated activity of sensory, integrative and motor brain areas. As the sensory landscape undergoes change, the interaction among brain areas should also be dynamic and change depending on the situation. For example, when you meet a new person, initially you may try to memorize his or her face (encoding information), but the next time you see this person, you will recognize his or her face and may remember several events associated with this person (retrieving information). Given that the synaptic transmission between neurons is a basic unit of information processing, it is crucial to understand how synaptic modulation can change interactions among brain areas. (Erin M. Schuman, 2008)

Neurotransmitters, such as dopamine, norepinephrine, serotonin, or acetylcholine, play an important role in state-dependent modulation of the brain (Kodama et al., 2002; Robbins, 2005; Takakusaki et al., 2006). These neurotransmitters, often called neuromodulators, are synthesized and released from a relatively small number of specialized neurons, which are primarily located in several distinct nuclei in the basal forebrain, midbrain or brainstem (Siegel et al., 1999). Through long-range connections these neuromodulator-releasing neurons make synaptic contacts with many different brain areas. Neuromodulators released from synaptic terminals are also capable of diffusing over substantial distances (>10 μm) and can act on receptors remote from release sites (volume transmission; Venton et al., 2003; Zoli et al., 1998). Thus, at the apparent cost of spatial selectivity, the information from neuromodulator-releasing neurons can be broadcast to a large area of the brain. As such, activity changes in a small number of neurons can exert a broadcast influence on many brain areas, coordinating a functional change across areas (Hasselmo, 1995).

In electroencephalograms or local field potential recordings, the brain activities are observed as multiple oscillators at different frequencies. A number of studies have described apparent links between specific oscillatory activities and particular brain functions (Buzsaki and Draguhn, 2004; Osipova et al., 2006; Palva and Palva, 2007). These oscillatory activities are not just epiphenomena, but the brain appears to utilize them for information coding, for example, to bind distributed information in the cortex (Engel et al., 2001; Varela et al., 2001) or to select phase-locked activities (Laurent, 2002). These results imply that oscillatory activities may play an important role in regulating information flow in the brain. Thus, it is worthwhile to assess how a neuronal network will respond to different frequency stimulation.

In monosynaptic transmission, the magnitude of the postsynaptic response evoked by presynaptic stimulation is intrinsically dependent on stimulation frequency (Markram et al., 1998). For example, during the delivery of multiple stimuli at close time intervals, the size of postsynaptic potentials can become larger or smaller, phenomena known as paired-pulse facilitation or

depression, respectively (Zucker and Regehr, 2002). Both presynaptic and postsynaptic mechanisms have been implicated in these processes. For example, changes in neurotransmitter release probability, availability of readily releasable pool of synaptic vesicles (Dobrunz and Stevens, 1997), postsynaptic receptor desensitization (Koike-Tani et al., 2008) or surface mobility of postsynaptic receptors (Heine et al., 2008) have all been proposed to play an important role in frequency-dependent modulation of synaptic transmission.



(Erin M. Schuman, 2008)

Figure 1.0: Frequency Stimulation of Synaptic Nerves

Dopamine is a neuromodulator, that plays crucial roles in motor control, learning and memory, or addictive behavior formation (Hikosaka, 2007; Wise, 2004). Most dopaminergic neurons are located in two nuclei, the ventral tegmental area and substantia nigra compacta (Bjorklund and Dunnett, 2007). Activation of these neurons during animal learning has been well characterized in monkey. Schultz and colleagues examined the *in vivo* activities of dopaminergic neurons during a conditioning task. In this study, the activity of dopaminergic neurons appears to reflect differences between internal expectations and actual outcomes, i.e. expectation errors (Schultz, 1998). Thus, one function of the dopamine system is to provide information about the salience of environmental stimuli for learning (McClure et al., 2003).

THE PRODUCT: GAASSI CHIP

Given the scientific data/information, the design of the BMI is such that human safety is paramount while fulfilling its objective(s).

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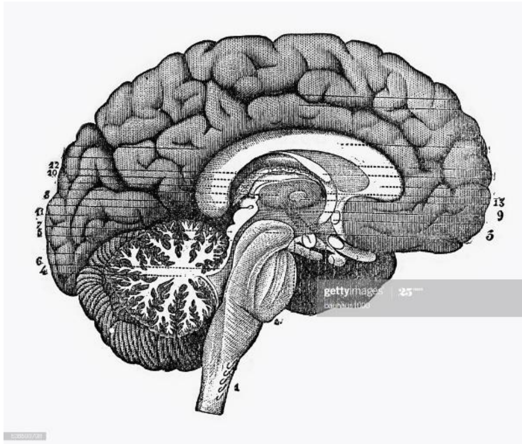

Figure 1.2: Brain Midsection

The BMI is designed as such that there will be an implantation of a micro-processing electrode in the midsection of the brain (just at the surface (can be on either hemisphere)) to enhance its capability to transmit signal input to and receive signal output from the brain. The chip with its electrodes will be placed just above the area of the medulla oblongata and the hippocampus. The frequency transmission is said to be greatest in this region because the neurons transmits as far as 5 micrometers.

This chip will have electrodes made of Gallium Arsenide (GaAs) and Silicon (Si) (commercial type) with a length of 1mm or less (size depends on brain density of the subject) and the diameter of the same. The electrodes will consist 90% GaAs and 10% Silicon, however, this may vary depending on the situation. The reason for choice of those materials are that they facilitate high bandwidth of frequency and watt dispensation. Also, evidential research has proven that photons/phonons are very high in these materials.

This is significant as it allows for scalability and improves bandwidth through the increase of wavelengths on the fiber. It must be noted also that commercial silicon has traces of Germanium, Gallium and Arsenic. These greatly help with bandwidth dispensation and power (in W s/cm^2).

This GaAsSi chip will be comprised of GaAs covered in silicon with a golden crystal in the center of the chip. The diameter of this golden crystal may be anywhere in the range of 0.5 mm to 2mm diameter. At no point will the GaAs come in contact with a human cell due to its toxicity. The silicon covering inclusive of the electrodes will be approximately 1mm thick (may be more or less depending on the situation).

These become effective as it will facilitate greater throughput in conversion from binary to analog and vice versa because there will be greater capabilities to create/draw data buses in nanometric context on the circuit while matching wavelengths will exist on the analog side of the device.

From what studies show, we will be able to acquire a bandwidth of 1nHz (Nano-Hertz) from these electrodes, and also able to achieve more. This fully surpasses the 10 Micro-Hertz threshold for general neuro-communication.

BY MACHEL ALLEN

When the signal from the computer reaches the chip, it makes contact with the Golden crystal which becomes electrically charged. The electrically charged atoms (electrons in particular) make contact with the electrons of the GaAs through a dipole moment creating an electric field which then makes contact with electrons of the Silicon forming one field and hence one electro-magnetic field through the magnetism which takes place once the atoms of the chip combine and the chip is placed in operation. This synergy gives the chip the power (in W s/cm^2) to emit at varied wattage (up to 1000 W s/cm^2 and possibly greater) and frequencies (10^2 Hz to 10^{18} Hz and possibly more).

Gallium Arsenide at 300 Kelvin has an electron mobility of 9000 cm^2 (Volts per second or V.s) to 10000 cm^2 (Volts per second or V.s), a band gap of 1.441 eV and an electron thermal velocity of 4.4 x 10^5 meters per second (m/s). This makes GaAs faster than 299, 792, 458 meter per second, the very speed of light.

Below are tables displaying the electrical properties of the materials (at 300 Kelvin) of the GaAsSi chip:

GALLIUM ARSENIDE

PROPERTIES	MEASURMENT
Breakdown Field	$\approx 4x10^5$ V/cm
Mobility Electrons	≤ 8500 cm^2 V^{-1} s^{-1}
Mobility Holes	≤ 400 cm^2 V^{-1} s^{-1}
Diffusion Coefficient Electrons	≤ 200 cm^2/s
Diffusion Coefficient Holes	≤ 10 cm^2/s
Electron Thermal Velocity	$4.4x10^5$ m/s
Hole Thermal Velocity	$1.8x10^5$ m/s

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SILICON

PROPERTIES	MEASURMENT
Breakdown Field	$\approx 3x10^5$ V/cm
Mobility Electrons	≤ 1400 cm^2 V^{-1} s^{-1}
Mobility Holes	≤ 450 cm^2 V^{-1} s^{-1}
Diffusion Coefficient Electrons	≤ 36 cm^2/s
Diffusion Coefficient Holes	≤ 12 cm^2/s
Electron Thermal Velocity	$2.3x10^5$ m/s
Hole Thermal Velocity	$1.65x10^5$ m/s

BY MACHEL ALLEN

GERMANIUM

PROPERTIES	MEASURMENT
Breakdown Field	$\approx 10^5$ V cm^{-1}
Mobility Electrons	≤ 3900 cm^2 V^{-1} s^{-1}
Mobility Holes	≤ 1900 cm^2 V^{-1} s^{-1}
Diffusion Coefficient Electrons	≤ 100 cm^2 s^{-1}
Diffusion Coefficient Holes	≤ 50 cm^2 s^{-1}
Electron Thermal Velocity	$3.1x10^5$ m s^{-1}
Hole Thermal Velocity	$1.9x10^5$ m s^{-1}

GOLD

PROPERTIES	MEASURMENT
Breakdown Field	$\approx 10^3$ V/cm
Mobility Electrons	30-50 cm^2/V.s
Mobility Holes	≈ 100 cm^2/ V.s
Diffusion Coefficient Electrons	$\approx 8.4x10^{-15}$ cm^2/s $\pm$ $2.5x10^{-15}$ cm^2/sec (estimated error)
Diffusion Coefficient Holes	$\approx 8.4x10^{-15}$ cm^2/s $\pm$ $2.5x10^{-15}$ cm^2/sec (estimated error)
Electron Thermal Velocity	

Hole Thermal Velocity	

Figure 2.1 below displays an atom with its nucleus and electron:

Figure 2.1: Atom with its electron

Figure 2.2 below displays the atom when combined with other atoms showing how electrons move between and among other atoms representing the electric field shared:

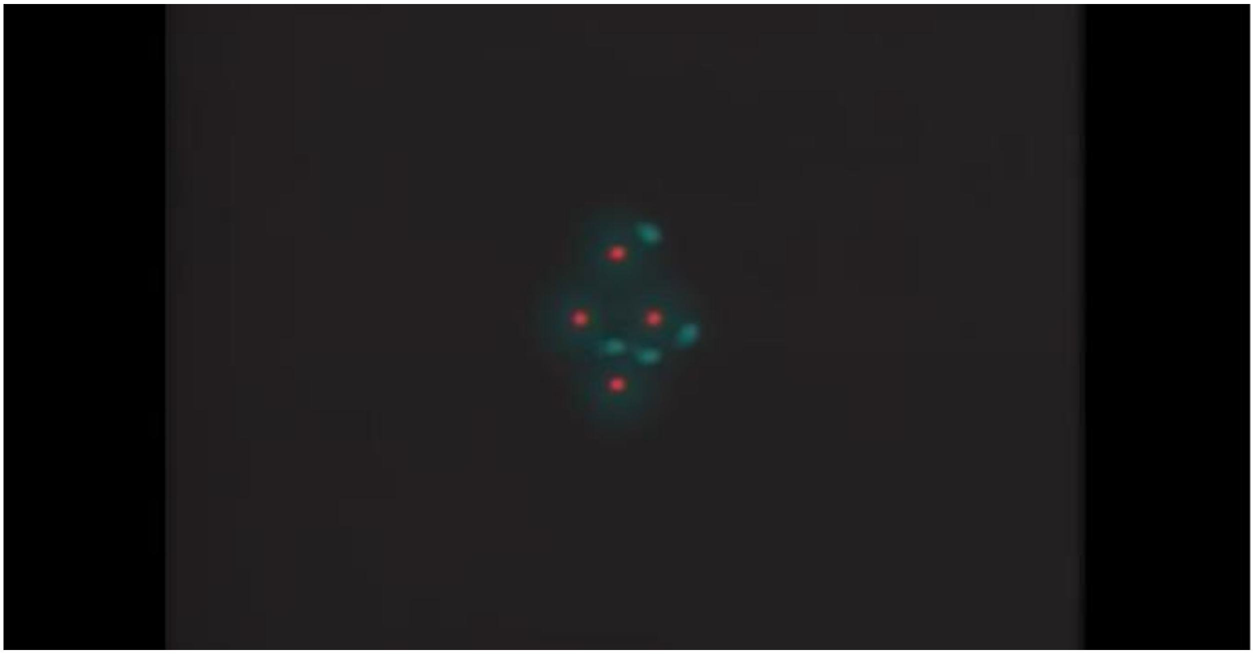


Figure 2.2: Electron Sharing

Figure 2.3 below displays the electro-magnetic field created between two atoms after a dipole moment has taken and magnetism as a result of such:

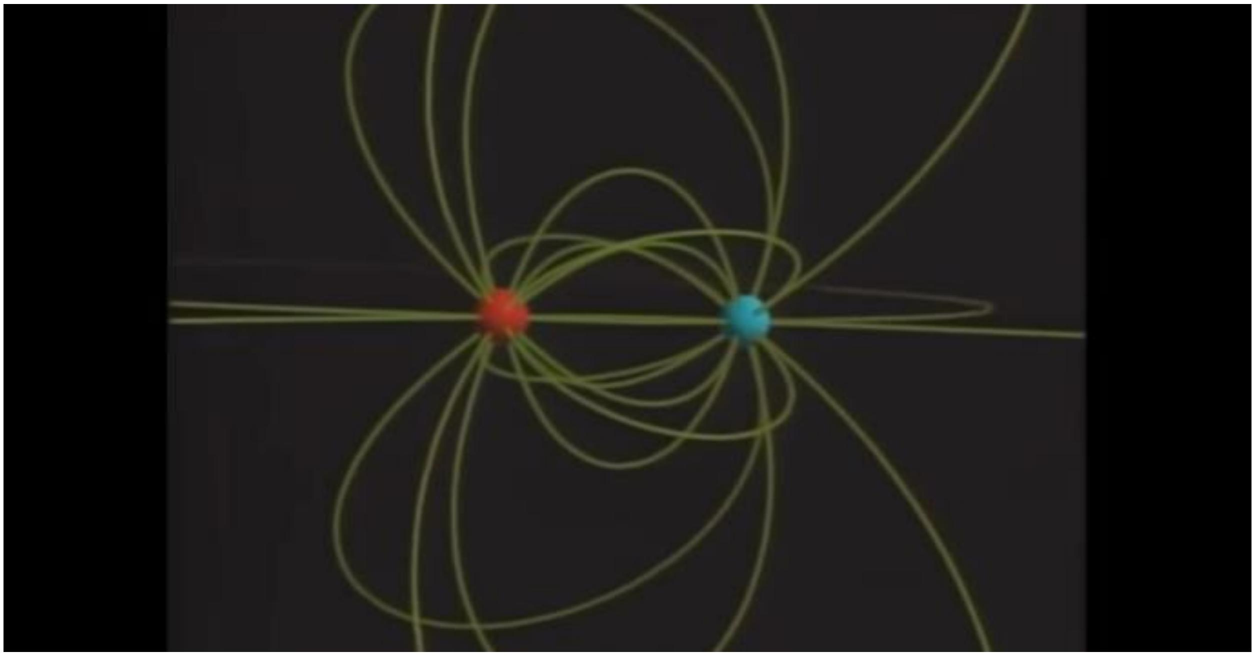


Figure 2.3: Electro-Magnetism

Notice the bond between the atomic particles and as several lines make contact, an electro-magnetic wave produces.

The synergy of the photons (light)/phonons (sound) created by the moving electrons and holes (absence of electrons) of the atomic particles of the respective materials will generate (once phonons are on the same frequency) a superimposed frequency and hence electro-magnetic propagation.

BY MACHEL ALLEN

THE SPINAL VERTEBRAE COLUMN

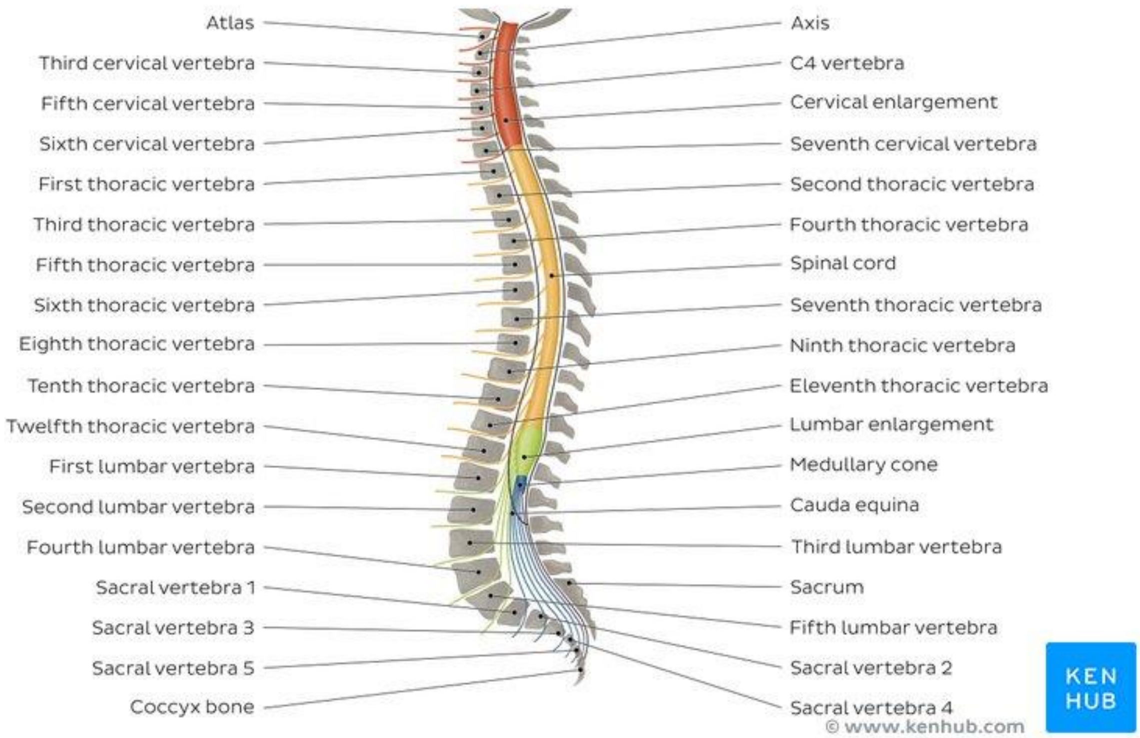


Figure 3.1: Vertebrae Column

The Spinal Cord is long, thin structure made up of nervous tissue. This runs from the medulla oblongata consisting of the hippocampus and runs downward to the lumbar region. It encases the cerebrospinal fluid. The brain and Spine is what makes up the Central Nervous System (CNS). The vertebral column is the bony structure which protects the spinal cord. It is approximately 45 cm (18 in) and aroung 43 cm (17 in) for women. The diameter ranges from 13 mm (1/2 in) in the cervical region and lumbar area and 6.4 mm (1/4 in) in stochastic region.

The Spine function is fundamentally in the transmission of nerve signals from the motor cortex to the rest of the body. As well, carrying brain signals from the sensory afferent fibers to sensory cortex. Motor instructions are controlled by these circuit-paths.

The main component of the Nervous System are the Nervous/Neural Tissue. Body operations are managed by the nervous system. The sending and receiving of nervous impulses and neuroglia or glial cells (Schwann cells) are done by nerve cells/neurons. The glia assists with the propagation of nerve impulses and provide nutrients to the the neurons.

BY MACHEL ALLEN

Nervous tissue is made of several types of neurons, which has axon. An axon is the stem-like part of the cell that sends nerve impulse to the next cell. Major groups of axons make up nerves in the Peripheral Nervous System (PNS) and connecting fibers of the nuclei of the Central Nervous System (CNS).

Neurons are cells with specialized features and possess a large soma/cell body with dendrites and an axon (both are forms of cell projections). Dendrites are projections branching that are thin that receive electrochemical signaling (neurotransmitters) to create a change in the voltage in the cell. Axons carry action potentials away from cell body toward the next neuron. They are long projections. The bulb-like end of the axon (axon terminal) is seperated from the dendrite of the neuron following by the synaptic cleft. When nerve impulse travels to the axon terminal, the neurotransmitters are sent across the synapse where it is received by the post-synaptic receptors continuing the communication.

Following harm to a peripheral nerve, the damaged axons declines in quality. In a few weeks, they regenerate and from thence recovered by myelin (insulating sheath which envelops the axon). This myelin enables rapid transmission of electrical pulses. However, the Schwann or glial cells do not regenerate the myelin sheath completely. Hence, the function of damaged nerves often remain impaired and certain muscles paralyzed in affected patients.

It has been proven that the growth factor neuregulin1 supports nerve repair and the redevelopment of the myelin layer. This protein is created by neurons and stationed on axons where it operates as important signal for the development of Schwann or glial cells and myelin formation. In lieu of the rapid degeneration of axons after injury, the Schwann cells remaining lose communication with axons. Hence, there is a lack of neuregulin1 signal of the nervous fibres.

Synthesizing the neuregulin1 protein until axons are fully grown, has been shown to develop the Schwann cells and regenerate the myelin sheath after injury. From thence the neuroglia cell will contribute to the repair of the myelinated axons.

However there is another problem, the scar tissues that develop in the healing process post operation.

BY MACHEL ALLEN

GAASSI CHIP APPLICATION

Once surgeons have performed the operation, the GaAsSi Chip(s) will be placed above and/or below the affected area (separate from the implantation in the brain), along the vertebrae column. The purpose of this implantation is to stimulate the area affected with electro-magnetic propagation. The electrodes, which may vary in size in this situation, will be placed appropriately so as to effect proper therapy. This is in an attempt to heal the scar tissues that arise.

In a study done by Perea Clinic Ltd London, frequencies in the region of 0.8MHz to 1MHz has been known to heal scar tissues.

It involves the use of a round-headed wand (probe) that is put in direct contact with your skin. It produces a wave that vibrates at about 0.8 to 1.0 Mhz. This wave can pass through the skin, and produces a vibration of the local tissue. (Yaneth Perea, 2015)

However, in a study done by scientists from Germany suggests frequencies in the region of 510kHz to 4.36MHz.

Here, the responses of primary enteric (ENS) and central nervous system (CNS) neural stem cells were investigated to different frequency – energy density – combination treatments between 510 kHz–3 W s/cm^2 and 4.36 MHz–25 W s/cm^2. Responses to ultrasonic treatments were both frequency and energy density dependent. Ultrasound enhanced the expansion and showed enlarged neurospheres for both ENS and CNS neural stem cell cultures. Differentiation was not impaired in regard to neuronal and glial cell number as well as neurite and glial fiber outgrowth. (Anne Schuster et al., 2017)

From the studies above, it appears frequencies in the region of 510kHz to 4.36MHz has the bandwidth and propagation to treat these scar tissues. A further study shows that increasing the wattage 600 W s/cm^2 has been proven in mice to remove the malignant cells that cause scar tissues to develop.

The GaAsSi chip will have the potency to generate wattages up to 1000 W s/cm^2 and greater. This will have the capability to prevent and remove the malignant cells forming scar tissues and improve blood flow giving the brain passage to communicate with parts of the body previously

unreachable due to injury. However, caution has to be taken because wattages of these amount can greatly displace neurons (beyond their determination point).

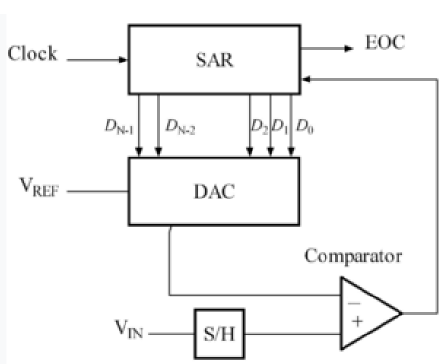
Once the Medical Doctor applies 600 W s/cm^2 (or so) to the area affected, he/she will have to monitor the area consistently using the appropriate frequencies to make certain the patient is not over-doped with radiation. When the malignant cells have been fully removed and/or the area properly sustained then the Medical Doctor (MD) can cease the radiation.

The chip implant in the brain is necessary to teach the brain to improve its own internal frequencies and wattage to exceed the appropriate thresholds to make proper communication down the spinal column. The brain does this by using its own internal metals (iron, copper, magnesium, zinc, etc.) and nutrients responsible for hemoglobin to generate frequencies which will then be propagated down the vertebrae column. This is once a proper operation has been done and the proper treatment(s) given to the patient.

This will especially be beneficial during therapy and helping patient to gain motility in limbs previously unreachable due to injury. Proper therapy should be given to patient to help train patient to use limbs once again.

The GaAsSi chips will be able to speak wired and wirelessly with each other (inclusive of chips implanted in the brain) and with the external computer. The user of the machine/computer, according to preference, will be able to synchronize and desynchronize the GaAsSi chip(s) in its functions and operations.

Sample Analog to Digital Conversion:



Successive-approximation ADC block diagram

Figure 4.1: Analog to Digital Conversion

BY MACHEL ALLEN

Key

DAC = digital-to-analog converter
EOC = end of conversion
SAR = successive approximation register
S/H = sample and hold circuit
V_{in} = input voltage
V_{ref} = reference voltage

SAMPLE PROGRAM/CODE (in C++)

```
#include <library ieee>
#include <ieee.std_logic_1164.all>
#include <ieee.numeric_std.all>
#include <iostream.h>

void main {
int ADC_8_bit {

float analog_in;
 port (analog_in ( float a >= -15.0 && a =< +15.0)
       digital_out : out std_logic_vector(int b > 7 && b=< 0)

} return 0;

ADC_8_bit = const conversion_time (float time = 25 ns);

 signal instantly_digitized_signal : std_logic_vector(b > 7 && b=< 0);
 signal delayed_digitized_signal : std_logic_vector( b > 7 && b=< 0--);

 int ADC_8b_10v_bipolar (
   analog_in (a >= -15.0 && a =< +15.0)
 ) return std_logic_vector =
   const int max_abs_digital_value= 128;
   const float max_in_signal= 10.0;
   float analog_signal;
   float analog_abs;
   float analog_limited;
   int digitized_signal;
   int digital_out: std_logic_vector(b > 7 && b=< 0);
 {
   analog_signal =  (analog_in);
   if (analog_signal < 0.0) {  int ip < 0;
     digitized_signal = int (analog_signal * 12.8);
     if (digitized_signal < -(max_abs_digital_value)) {
       digitized_signal = -(max_abs_digital_value);
```

```
      }
}
    else {
      digitized_signal = analog_signal * 12.8;
      if (digitized_signal > (max_abs_digital_value - 1)) {
        digitized_signal = max_abs_digital_value - 1;
      }
    }
    digital_out = std_logic_vector(to_signed(digitized_signal, digital_out_length));
    return digital_out;
  } ADC_8b_10v_bipolar;

 {

  instantly_digitized_signal <=
   std_logic_vector (ADC_8b_10v_bipolar (analog_in));

  while (instantly_digitized_signal >= conversion_time){

  delayed_digitized_signal <= instantly_digitized_signal;

 digital_out <= delayed_digitized_signal;

  }

 }
cout.flush();
 }
```

There will be a hard (burnt-in) and soft address to facilitate security concerns. Therefore, the internal chips will only communicate with each other and a specific computer(s) unless they are officially programmed otherwise. With respect to data communication, 5G (and higher) data communication will be required to guarantee proper sync between internal chips and external computer(s).

BY MACHEL ALLEN

THE GAASSI ARCHITECTURE

The GaAsSi Chip consists of Stimulation, Electrode Diagnostics, Power Management, Analog Amplifiers, Analog-to-Digital Converters, Processing Logic, 5G (and higher) Radio Frequency (RF) Transceiver and/Sensor Feedback. This connects to a Data Transfer Coil, which connects to a computer terminal. The Cable Connectors will be placed just under the epidermis.

The Manufacturer would have the right based on user request to remotely troubleshoot any technical issues that may develop during use of the chip (where necessary), or user could go in for in-person adjustments to the chip (of course upon certification and assistance from a MD). However, the GaAsSi Chip(s) would be programmed as such to automatically raise a flag in the event of any technical issues that may develop during its use.

The GaAsSi Chip Implantation consists of twelve (12) Application-Specific-Integrated Circuits (ASICs) each containing 500 to 1000 electrodes. This results in 6, 000 to 12, 000 individually programmable amplifiers and 6,000 to 12,000 channels overall. This will enhance better reception of analog signals to the brain and transmission of signals thereto. The Language of choice is C++. Overall, there will be four (4) Chip Implantations in the brain and as a result 24,000 to 48,000 electrodes from the Sensors to the External Computer.

STIMULATION:

Brain stimulation therapies can play a role in treating certain mental disorders. Brain stimulation therapies involve activating or inhibiting the brain directly with electricity. The electricity can be given directly by electrodes implanted in the brain, or noninvasively through electrodes placed on the scalp. The electricity can also be induced by using magnetic fields applied to the head. While these types of therapies are less frequently used than medication and psychotherapies, they hold promise for treating certain mental disorders that do not respond to other treatments. (National Institute of Mental Health, 2016)

From the Scientific Data/Information presented under "THE HUMAN BRAIN: NEURO-TRANSMITTANCE", the synaptic nerves respond to different frequency levels. Hence, the Stimulation Engine would be so designed that 6 ASICs (with their respective electrodes) would be placed among monosynaptic nerves and 6 ASICs (with their respective electrodes) would be placed among disynaptic nerves.

BY MACHEL ALLEN

When the sensors detect a lapse in communication from the synaptic nerves the Microprocessor Implantation will detect such lapses and is automatically configured to generate the appropriate frequencies to stimulate such nerves. From research disynaptic nerves responds best to frequencies in the range of 50 to 200 Hertz, while monosynaptic nerves respond best to frequencies in the range of 10 microhertz and lower.

In disynaptic nerve communications lapse, the Stimulation Engine will generate 50 to 200 Hertz to stimulate activity. It will do this over a 30 second to 2 minutes period. It will automatically increase by the tens until positive responses are detected. While in monosynaptic nerve communications lapse, the Stimulation Engine will generate in the range from 10 microhertz to 10 nanohertz to stimulate activity. The Stimulation Engine in this situation will do continuous (non-time specific) frequency propagation until positive responses are detected.

The reason for the above approach, is that research has shown that monosynaptic nerves respond best to low continuous frequencies and disynaptic nerves respond best to short periods of high frequencies. Even though low frequency monosynaptic nerve(s) stimulation does trigger disynaptic nerve(s), the disynaptic nerves themselves respond to higher frequencies.

General Formula:

$$S_{AM} = -0.5[\cos(2\pi(f_c + f_m)t) + \cos(2\pi(f_c - f_m)t)], \qquad (1)$$

$$S_{FM} = \sin(2\pi f_c t + M \sin(2\pi f_m t)) \qquad (2)$$

Where AM is Amplitude Modulation, FM is Frequency Modulation, f_c is Carrier Frequency, f_m is Message Frequency, t is period (in time) and M is Modulated Signal.

AMPLIFIERS AND ANALOG-TO-DIGITAL CONVERTERS:

An electronic amplifier is an electronic system that increase voltages. The system's power supply provides the energy required for amplification. A perfect amplifier does not interfere with the input signal. The output is an exact reproduction of the input signal but of increased pitch. It is a live quadripole based on active component(s), for example, transistor and operational amplifier.

BY MACHEL ALLEN

Electronic amplifiers are implemented in most electronic circuits. They are able to give rise to electrical signals, in the case of a sensor's output, to a level of voltage that can be used by the rest of a given system. They can also improve the maximum power that a system has available and can provide to power to a charge such as a speaker and radio antenna.

Pixel Aspect Ratio (PAR) is a mathematical ratio that explains how the width of a pixel in a digital image compares to the height of that pixel.

The Display Aspect Ratio (DAR) is the ratio of the height of an image*;* for TV, DAR was traditionally a four-to-three ratio, 4:3 (full screen) and a sixteen-to-nine ratio, 16:9 (widescreen) the present standard for High Definition TV. With the Storage Aspect Ratio (SAR) for Digital Imagery, there is a difference, that is, the ratio of pixel dimensions. When the image is displayed with square pixels, then these ratios agree; if not, then non-square and these ratios disagree.

The Pixel Aspect Ratio (PAR) are related by the identity:

$$\text{SAR} \times \text{PAR} = \text{DAR} \quad (3)$$

The square pixels are 1:1.

Rearranging yields:

$$\text{PAR} = \text{DAR}/\text{SAR} \quad (4)$$

A 680 × 520 Video Graphics Adapter image has a SAR of 680/520 equaling a four-to-three ratio, and if previewed on a four-to-three ratio display (DAR = 4:3) has square pixels, hence a PAR of an one-to-one ratio. On the contrary, a 744 × 600 D-1 Phase Alternate Line has a SAR of 744/600 equaling a five-to-four ratio, but is displayed as a DAR equaling a four-to-three ratio.

In analog images there is no notion of pixel, nor notion of SAR or PAR, but in the digitization of analog images the resulting digital image has pixels.

BY MACHEL ALLEN

The Application of Laplace And Fourier Transform

Laplace Transform

The essential component of the Laplace transform takes the differentiation of components and multiplies them by:

for s = (σ ,ω) (5)
L(*f* ')(s) = sL(*f*)(s) - *f*(0)

Given the differentiation of product rule: (uv)' = u'v + v'u,
integrating both sides gives (6)

$$u(b)v(b) - u(a)v(a) = \int_a^b (uv)' = \int_a^b u'v + \int_a^b uv'$$

Therefore, the u=$e^{-\sigma t}$(cos(ωt), -sin(ωt)), and dv = *f* ', there is u'=(-σ,-ω)u, and v=*f*, and (7)

$$0f(\infty) - 1f(0) = (-\sigma, -\omega)\int_0^\infty f(t)e^{-\sigma t}(\cos(\omega t), -\sin(\omega t)) + \int_0^\infty f'(t)e^{-\sigma t}(\cos(\omega t), -\sin(\omega t))$$

so that
L(*f* ')(s) = sL(*f*)(s) - *f*(0)
The important matters here are that the differentiation of the product rule and the situation that differentiating lowered oscillation(s) results in multiplication of that/those oscillation(s) by a constant value.

Fourier Transform

Periodic functions can be approximated by Fourier series. This result is likely to be broadened to express any procedure as an integral of sine and cosine components. Let *f* be a function and define f_T to be the periodic extension of *f* on the interval -T/2 to T/2, that is, $f_T = f$ on the interval -T/2 to T/2 and f_T is periodic with period T. Then f_T is an estimated value of a Fourier series. The Fourier series utilizes multiples of frequencies that are based on frequency 1/T cycles per second. As T goes up in numerical value, f_T value goes to *f*, so the spacing in between the approximated frequencies, that is 1/T, decreases. In the limit, a replacement of the summation of the integral series is necessary. The Fourier Integral Theorem is where the integral equals *f*. The variables of the sine and cosine individual composites are stated by the Fourier transform.

Fourier cosine transform and the Fourier sine transform derives the Fourier Transform. The Fourier cosine transform series *f* is explained by any frequency deemed realistic by λ cycles per second is

(8)

$$A_f(\lambda) = 2\int_{-\infty}^{\infty} f(t)\cos(2\pi\lambda \mathrm{t})$$

and the Fourier transform of the value *f* is discussed as (9)

$$B_f(\lambda) = 2\int_{-\infty}^{\infty} f(t)\sin(2\pi\lambda \mathrm{t})$$

The Fourier Integral Theorem (FIT) explains that (10)

$$f(\mathrm{x}) = \int_0^{\infty} A_f(\lambda)\cos(2\pi\lambda \mathrm{x})\mathrm{d}\lambda + \int_0^{\infty} B_f(\lambda)\sin(2\pi\lambda \mathrm{x})\mathrm{d}\lambda$$

It is assumed $f(\mathrm{x}) = 0$ for $\mathrm{x} < -T_0/2$ and $\mathrm{x} > T_0/2$. It is believed *f* the transform of sine is 0. The values of the Fourier series for f_T (were f_T matches *f* for $-T/2 < t < T/2$, and relates to be congruent with specific periods of time (T), which are then (11)

$$A_j = A(j/T) = 2/T\int_{-T/2}^{T/2} f(t)\cos(2\pi \mathrm{jt/T}) = 2/T\int_{-\infty}^{\infty} f(t)\cos(2\pi \mathrm{jt/T}) = A_f(j/T)/T \text{ for } j = 0,1,2...$$

It is estimated that FIT integral by splitting the range of waves into intervals of size h=1/T and adding with (12)

$$\int_0^{\infty} A_f(\lambda)\cos(2\pi\lambda x)d\lambda <-$$

$$(1/T)\sum_{j=0}^{n} TA(j/T)\cos(2\pi jx/T) = \sum_{j=0}^{n} A(j/T)\cos(2\pi jx/T) = S_n(f_T, x)$$

Explanation

Laplace and Fourier Transform are used in conjunction with each other to mitigate against the Nyquist Effect and bring sinusoidal (and other types of) waves to its pure form. Signals are amplified using Laplace Transform and hence exceeding the threshold to overcome noise/attenuation on a channel(s). Fourier Transform is then used to sub-divide sinusoidal waves (and also other types of waves) into periods of time. Here signals are looked at introspectively to remove any other electromagnetic interference and extract data for digitization and hence conveying an accurate representation of analog data in binary form.

The processing of the analog waves occurs 100 picohertz. The Microprocessor Implantation accepts 80, 000 samples per second (80 milliseconds or 80 Megabits per second) and process them using 16 Core Computers. This Operation overall happens so fast that the brain will not recognize.

BY MACHEL ALLEN

The Nyquist Theorem is a principle in the digitization of analog signals. For analog-to-digital conversion (ADC) to result in a faithful reproduction of the signal, the analog waveform must be taken frequently. The Nyquist Effect is when signals become halved when they exceed a threshold (that a system is unable to keep up with).

Any analog signal has several frequency elements. An example, the sine wave where all energy is concentrated at one frequency. Analog signals have complex waveforms with varied frequency elements. The highest frequency measurement dictates the bandwidth for that analog signal. Frequency is proportional to bandwidth, if all other considerations remain the same.

The Nyquist Theorem for a given analog signal $f_{\max}$ is at least $2f_{\max}$. The sampling in an analog-to-digital converter is actuated by a pulse generator (clock). If the sampling rate is less than $2f_{\max}$, the highest frequency components are not guaranteed be correctly represented in the digitized output. When such a digital signal is converted back to analog form by a digital-to-analog converter, it does not return to its original analog signal or even near so. This undesirable condition is a form of distortion called aliasing.

The Nyquist–Shannon sampling theorem serves as a fundamental bridge between continuous-time signals and discrete-time signals. It establishes a appropriate situation for a sample rate that permits a discrete sequence of samples to capture all the information from a continuous-time signal of bounded/limited bandwidth.

The theorem is applicable to a class of mathematical functions having a Fourier transform that is zero outside of a certain region of frequencies. It is anticipated that when a continuous function reduces to a discrete sequence, it returns to a continuous function, the fidelity of the result depends on the sample rate of the original signals.

The theorem for experimentation (or sampling) is designed so that no information is lost and that the actual fidelity for the class' hierarchy to certain bandwidth is band-limited. It shows the sampling as an expression of the bandwidth for specific hierarchy of function(s). The theorem is effectively a formula for the reconstruction of the original continuous-time or analog function from collected waveforms.

Perfect reconstruction is probable even when the sample-rate criterion is not satisfied, given other limitations on the signal are established. In some situations where the sample-rate criterion is not met, using additional constraints allows for estimated reconstitution. The fidelity of these reconstitutions can be verified and quantified with Bochner's theorem.

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RADIO FREQUENCY (RF) TRANSCEIVER:

With carrier aggregation (CA) and advanced-MIMO techniques, the New Radio (NR) devices can attain up to several Gb/s peak data-rate. The demand of high bandwidth has created a need for exploring high-frequency spectrum over 3GHz, while sustaining legacy Long Term Evolution (LTE) bands for LTE-NR dual connectivity (EN-DC). Since User Equipment (UE) requires small form-factor and low power consumption, a single-chip RF transceiver is essential to cover both NR and legacy protocols, simultaneously. This integrated CMOS (complementary metal-oxide-semiconductor) Radio Frequency Integrated Card (RFIC) that supports multimode and multiband applications including all the legacy 2G, 3G, 4G and stand-alone/non-stand-alone sub-6GHz 5G NR features.

According to the Third Generation Party Project (3GPP) (release 15) standards, 5G NR (New Radio) can operate in two frequency bands: FR1 and FR2 [1]. In this paper, a transceiver (TRx) operating in Time Division Duplex (TDD) mode at 3.5 GHz (FR1 band) is chosen for analysis. A band pass filter is one of the crucial components in wireless transceiver (TRx) systems. The overall system specification and Radio standards requirement are mostly covered by Filter's specification. In TRx system, filters play a major role in improving the selectivity of the receiver, rejecting spurious harmonic noise generated within the system and making the system more immune to unwanted radio signals. (L. Punitha et al., 2019)

The Tx chain contains a cascade of driver amplifier that conditions the input signal, a Band Pass Filter (BPF) operating at the desired frequency band, and a power amplifier (PA) to improve the pitch of signals to a required level for the antenna to transmit. The Rx chain consists of a low-noise amplifier (LNA) to increase the signal power to an appropriate level for detection with the Band Pass Filter as a digital attenuator for adjusting the gain of the system and also an amplifier (AMP) for processing the signals. The antenna is joined to the Tx and the Rx chain through a single pole double throw (SPDT) RF switch. In conjunction, a directional coupler (DC) can be placed after the antenna for supervision and standardization purposes.

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5G RADIO FREQUENCY (RF) TRANSCEIVER CONFIGURATION

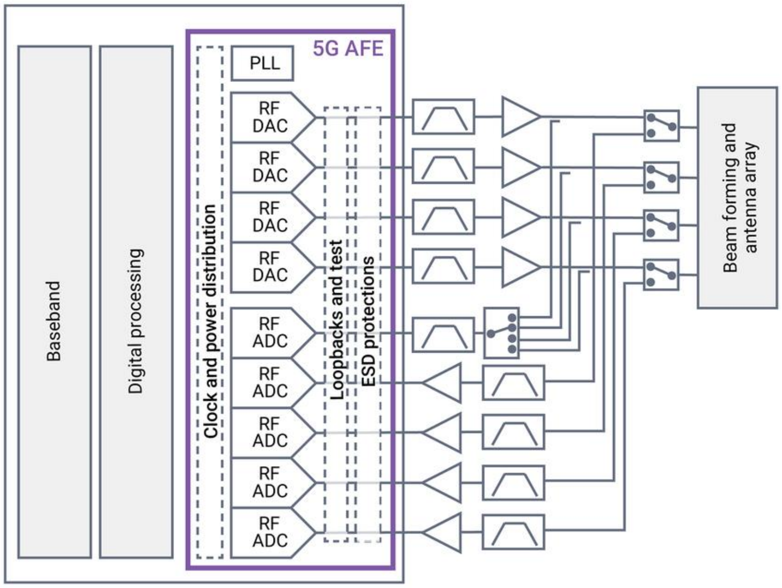

Figure 5.1: 5G RF Transceiver Architecture

ELECTRODE DIAGNOSTIC:

The medical electrode transfers the energy of ionic currents in the body into electrical currents that can be amplified, studied, and used to help make diagnoses. The medical electrode passes ionic current's energy to the (human) body as electrical current that can be made higher pitched, researched and used for medical purposes.

Medical electrodes permit surface quantification of internal ionic currents, yielding an ordinarily non-invasive test for a variety of nervous, muscular, ocular, cardiac, and other disorders that might otherwise have required surgical means to verify their presence. For instance, muscular exams using electrodes may produce evidence of diminished muscle strength and can discriminate between primary muscle disorders and neurologically-based disorders, in addition to detecting if a muscle is truly weak or seems so due to other reasons. The electrodes are typically easy to use, fairly cheap, disposable (or easily sterilizable), and often unique in the tasks they help to perform. The essential role of the electrode is to provide ideal electrical contact between the patient and the apparatus used to measure or record activity. (Medical Encyclopedia, 2020)

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PROCESSING LOGIC:

This coordinates all the activities of the Microprocessor Implant Device. According to Unitronics, is a ruggedized computer used for industrial automation. These controllers can automate a specific process, machine function, or even an entire production line.

The Processing Logic receives information from connected sensors or input devices, processes the data, and triggers outputs based on pre-programmed parameters. Depending on the inputs and outputs, a Processing Logic can monitor and record run-time data such as machine productivity or operating temperature, automatically start and stop processes, generate alarms if a machine malfunctions, and more. Processing Logics are a flexible and robust control solution and are adaptable to any application.

POWER MANAGEMENT:

The Power Management System is designed according to Advanced Configuration and Power Interface (ACPI). ACPI is open standard that Operating Systems use to discover and configure hardware components to perform power management operations such as putting unused components to sleep and perform status monitoring.

The Power Management System is used to: reduce overall energy consumption, prolong battery life for portable and embedded systems, reduce cooling requirements, reduce noise and reduce operating costs for energy and cooling.

Lower power use means lower heat dissipation (leading systems stability) and less energy use and that reduce costs and reduce negative impacts on people and the environment.

SENSOR FEEDBACK:

Sensor is a device, module, machine, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics. (S. Bennett, 1993)

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The Sensor(s) relating to the GaAsSi chips are used for interfacing with the Electrodes causing the external device to speak with the chips and vice versa.

SPECIFICATIONS OF GAASSI IMPLANTATION

Channels	24, 000 to 48, 000
Root Mean Square Noise	7.2 microvolts
Amplifier/Analog-Digital-Converter Power	3.3 microwatts
Spike Detection	2,000 nanoseconds
Stimulation Resolution	0.2 microamperes and 3.0455 microseconds
Die Size	4 x 5 mm

CONCLUSION

Artificial Intelligence (AI) relates to the intelligence demonstrated by machines, in converse to that displayed by human beings. Any machine/device having the capabilities to recognize its surroundings and perform tasks to increase its chance(s) of successfully achieving its goals. AI describe machines ability to emulate cognitive actions that humans associate with the human mind in particular learning and problem solving.

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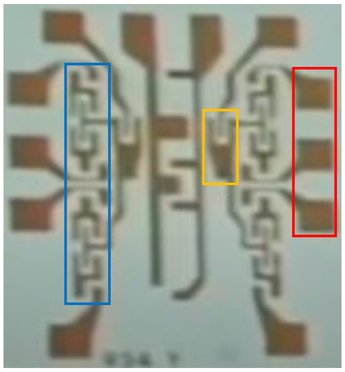
APPENDICES

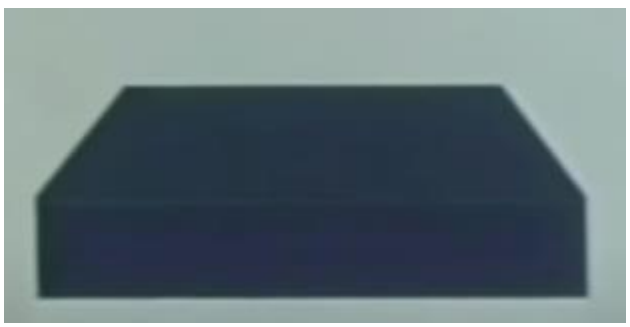
INTEGRATED CIRCUIT
(Made of Gallium Arsenide)



KEY
Red Box – Metal Plates
Blue Box – Transistors
Yellow Box – Diode

Millions of these will be placed on the Chip.

GAASSI CHIP DESIGN


Layer 1 – Gallium Arsenide (wafer)

Oxygen to react with the top surface and grow an oxide called passivating Gallium Arsenide dioxide layer. [Golden Crystal in the centre of the Chip]

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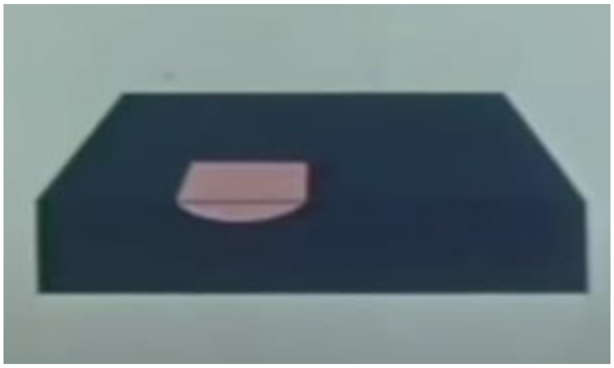
Layer 2 –
The wafer is coated using masks with a photosensitive resin.

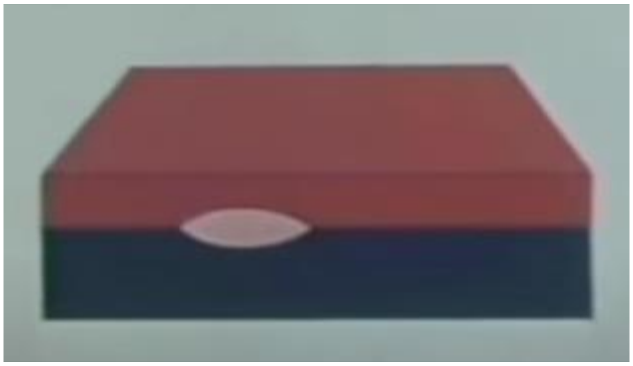
Layer 3 –
Another mask is placed on the resin and the system is exposed to light, as a result the exposed resin hardens.

Layer 4 –
The Hardened Resin is then rinsed away. The wafer is exposed to acids. The areas of the wafer not protected by the resin are etched away in the next operation referred to as diffusion. The wafer is exposed to a dopant.

Layer 5 –
The wafer is exposed to a dopant. This impurity diffuses through the window and into the Gallium Arsenide below forming the collector of a transistor in the integrated circuits on the chip. While Diffusion is taking place, more oxide is being formed. This is the essence of the planar process.



Layer 6 –
The passivating layer is stripped off.



Layer 7 –
Afterwards, a new layer of Silicon [purified through the same processes as described above] will be placed and allow to grow right on top of the diffused wafer by a process called epitaxial growth.

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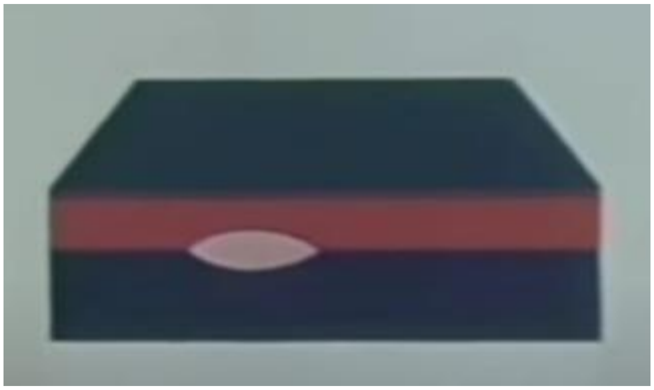
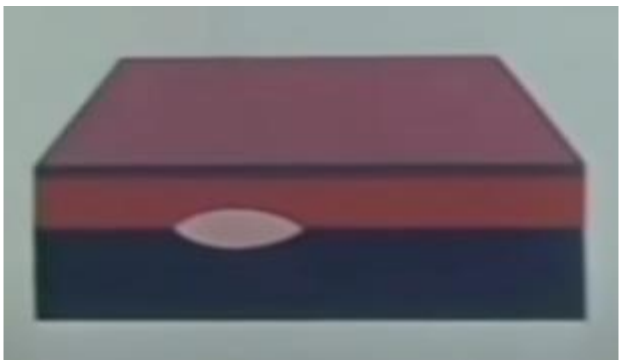
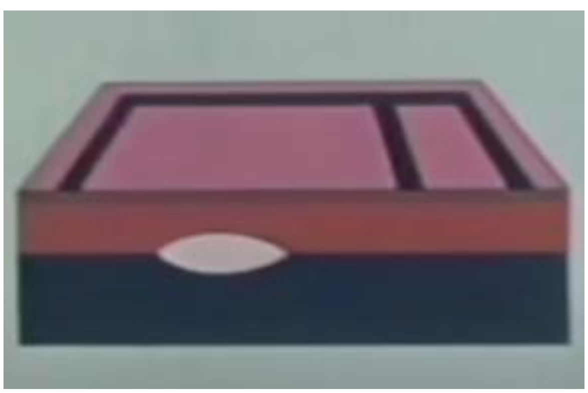


Layer 8 –
An electrically isolated region(s) will form on the wafer by a process of diffusion.



Layer 9 –
Afterwards, there will be a photosensitive coating masking exposure.



Layer 10 –
Rinsing, edging and diffusion takes place.

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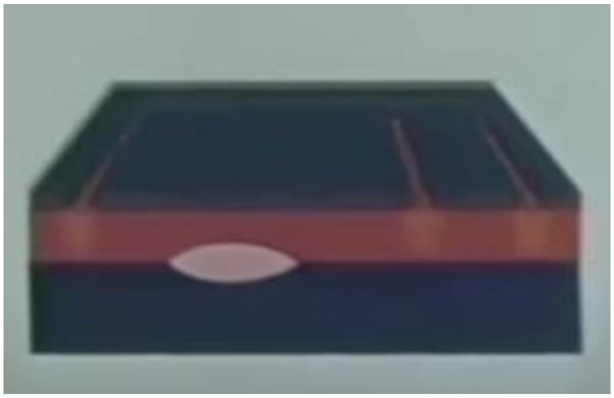
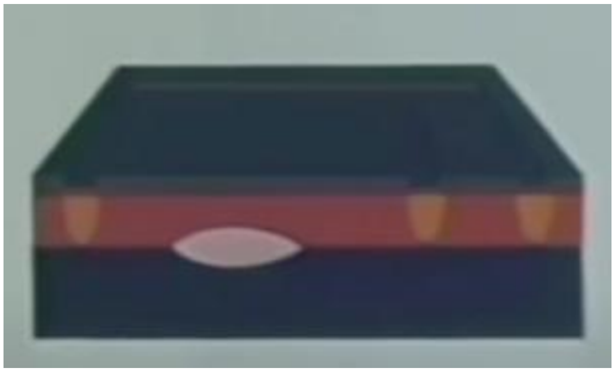
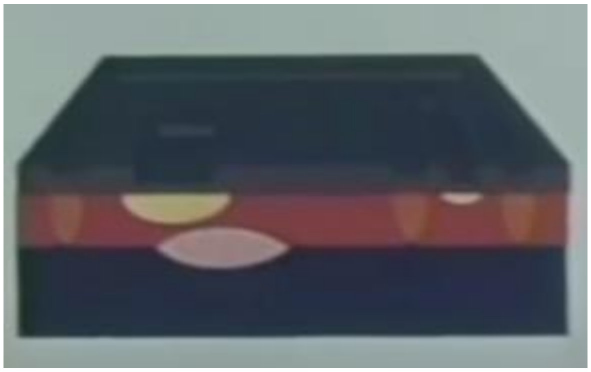


Layer 11 –
Afterwards, individual parts will be prepared for the integrated circuits.



Layer 12 –
There will a transistor base and resistors placed in each integrated circuit on the Chip.



Layer 13 –
Diffusion takes place downwards and laterally.

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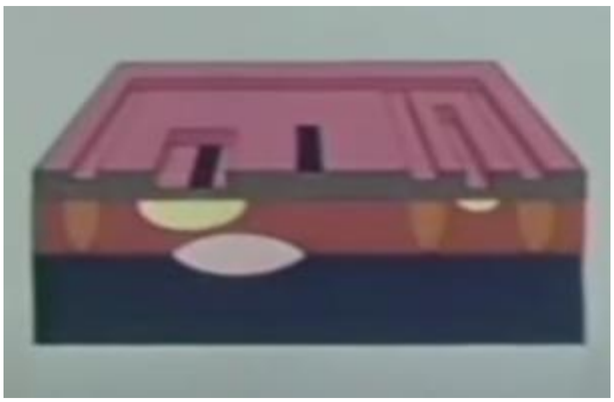
Layer 14 –
The Oxide as a result of the junction is formed beneath the passivating layer where it is protected from the outside world. The next diffusion forms an emitter.



Layer 15 –
And as well, collector contact to complete the transistor.

Layer 16 –
The next step enables the interconnecting of various components making contact with them.

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Layer 17 –
And again will etch windows in oxide.

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REFERENCES

Beatriz Alvarez-Castelo; Tom Dieck, Susanne; M. Fuso, Claudia; Donlin-Asp, Paul; D. Perez, Julio; M. Schuman, Erin (2008). The switch-like expression of heme-regulated kinase 1 mediates neuronal proteostasis following proteasome inhibition. Max Planck Institute for Brain Research, Germany (eLife Sciences Publications ISSN: 2050-084X) Retrieved from: https://elifesciences.org/articles/52714

Tim Pagden, Analog to Digital Converter Model. 2 February 1996. Retrieved from: https://www.doulos.com/knowhow/vhdl_designers_guide/models/analogtodigital_converter_model/
Computer Methods in Applied Mechanics and Engineering, Volume 353, 15 August 2019, Pages 448-466.

Poole, David; Mackworth, Alan; Goebel, Randy (1998). *Computational Intelligence: A Logical Approach*. New York: Oxford University Press. ISBN 978-0-19-510270-3.

Russell, Stuart J.; Norvig, Peter (2009). *Artificial Intelligence: A Modern Approach* (3rd ed.). Upper Saddle River, New Jersey: Prentice Hall. ISBN 978-0-13-604259-4.

U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Mental Health. (2016). NIMH Strategic Plan for Research (NIH Publication No. 02-2650). Retrieved from: https://www.nimh.nih.gov/health/topics/brain-stimulation-therapies/brain-stimulation-therapies.shtml

Henri Lilen, A (brief) history of electronics, Vuibert, 2003, 640 pp. (ISBN 2711753360 and 978-2711753369), chapter 4: "Lee De Forest invents the Audion or tube triode."

International Telecommunication Union - Radiocommunication Sector (ITU-R) (January 2007). "Recommendation BT.601-6: Studio encoding parameters of digital television for standard 4:3 and wide screen 16:9 aspect ratios". *ITU Online Bookstore*. Retrieved October 1, 2008.

Nemirovsky, Jonathan; Shimron, Efrat (2015). "Utilizing Bochners Theorem for Constrained Evaluation of Missing Fourier Data". arXiv:1506.03300 [physics.med-ph].

Shannon, Claude E. (January 1949). "Communication in the presence of noise". *Proceedings of the Institute of Radio Engineers*. **37** (1): 10–21.

Berkeley Science Books, CWT Volume 4 – Good Vibrations, Fourier Analysis and the Laplace Transform, (2013): berkeleyscience.com/synopsis4.htm

BY MACHEL ALLEN

L.Punitha*, Sathya Priya Sugumar, and P.H. Rao, Senior Member IEEE SAMEER- Centre for Electromagnetics, Chennai, Analysis of RF transceiver for 5G application, (2019), www.ursi.org/proceedings/procAP19/papers2019/PID5638325.pdf

Bennett, S. (1993). *A History of Control Engineering 1930–1955*. London: Peter Peregrinus Ltd. on behalf of the Institution of Electrical Engineers. ISBN 978-0-86341-280-6The source states "controls" rather than "sensors", so its applicability is assumed. Many units are derived from the basic measurements to which it refers, such as a liquid's level measured by a differential pressure sensor.

Kalman, R. E. (1960). "A New Approach to Linear Filtering and Prediction Problems". *Journal of Basic Engineering*. **82**: 35–45. doi:10.1115/1.3662552

Li, Wangyan; Wang, Zidong; Ho, Daniel W. C.; Wei, Guoliang (2019). "On Boundedness of Error Covariances for Kalman Consensus Filtering Problems". *IEEE Transactions on Automatic Control*: 1. doi:10.1109/TAC.2019.2942826. ISSN 0018-9286.

Ruth M Stassart, Robert Fledrich, Viktorija Velanac, Bastian G Brinkmann, Markus H Schwab, Dies Meijer, Michael W Sereda, Klaus-Armin Nave. **A role for Schwann cell–derived neuregulin-1 in remyelination**. *Nature Neuroscience*, 2012; 16 (1): 48 DOI: 10.1038/nn.3281

Yaneth Perea. Why it is important to deal with scar tissue. 5 August 2015. Retrieved from: https://pereaclinic.com/deal-with-scar-tissue/

A.V. Alexandrov, C.A. Molina, *et al.***Ultrasound-enhanced systemic thrombolysis for acute ischemic stroke**
N. Engl. J. Med., 351 (21) (2004), pp. 2170-2178

E.S. Ang Jr., V. Gluncic, *et al.***Prenatal exposure to ultrasound waves impacts neuronal migration in mice**
Proc. Natl. Acad. Sci. U.S.A., 103 (34) (2006), pp. 12903-12910

S. Atar, U. Rosenschein**Perspectives on the role of ultrasonic devices in thrombolysis**
J. Thromb. Thrombolysis, 17 (2) (2004), pp. 107-114

M.H. Chen, J.S. Sun, *et al.***Low-intensity pulsed ultrasound stimulates matrix metabolism of human annulus fibrosus cells mediated by transforming growth factor beta1 and extracellular signal-regulated kinase pathway**
Connect. Tissue Res., 56 (3) (2015), pp. 219-227